

RAT
3974

6p.

SUPERIOR DIET

for

MAN IN SPACE

N 63 18374

CODE-1

CONTRACT NASW-517

QUARTERLY PROGRESS REPORT

10/4/62:1/4/63

Submitted

by

SCHWARZ BIORESEARCH, INC.
Mountain View Avenue
Orangeburg, N.Y.

January 1963

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OTS PRICE

XEROX \$ 1.10 pl

MICROFILM \$ 0.80 mf

CT-50,520

ABSTRACT

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The initial months of Diet Project NASW-517 have been devoted to organizing and special training of staff, acquisition of materials and specialized equipment, and carrying out a series of preliminary experiments. The necessary personnel have been hired and trained in the requisite techniques to handle problems associated with contract commitments. The required diet ingredients have been purchased and are currently being evaluated in terms of their purity and suitability for incorporation into diets. Finally, orders have been placed for instrumentation, equipment and animals that will be needed for the contemplated experimental program.

Critical evaluation of liquid chemically defined diets as presently constituted reveals the limitations of present formulations and the need to reformulate a number of new diet preparations for the purpose of achieving the following results:

- a) greater palatability
- b) greater resistance to oxidation
- c) elimination of browning reaction
- d) greater stability to environmental exposure and storage conditions.

Rat bioassays have been devised and will be used to ascertain the effects of replacement of specific diet constituents with both biochemically and organoleptically more compatible ingredients. Two materials which appear to require modification are D-glucose, because of its contribution to browning and L-methionine because of its undesirable effects on flavor.

Preliminary study has been undertaken to determine whether changing the form of the diet from liquid to a gel form can be satisfactorily achieved under conditions compatible with the diet ingredients.

Finally, in order to accelerate and simplify the assay procedure for determining the D-isomer present in L-amino acids, a microtechnique involving the use of Conway cells has been developed employing a D-amino acid oxidase.

PROGRESS REPORT

Following the results of taste panel analysis of the organoleptic properties of Greenstein Diet No. 116, the general consensus is that the diets in their present form are characterized by a general bitter quality superimposed on an underlying sweetness and that improvement is necessary for long-term use by humans.

Modification of the ratios of non-essential amino acids offers opportunities for better flavor balance. As an example, the presence of monosodium glutamate in the diet affords the possibility of utilizing it as a flavor base to which other flavors can be added to accentuate the desirable organoleptic properties of the diet. In this connection, the flavoring contribution of small amounts of 5'-inosinic and 5'-guanylic acids are being studied. These compounds have been reported to add appreciably to food acceptability when used in relatively low concentration, 0.01%-0.03%, in presence of monosodium glutamate.

The taste panel also identified L-methionine as the most objectionable diet ingredient by means of a single component evaluation.

An additional drawback of the preliminary formulation tested (Greenstein Diet No. 116) is the large amount of D-glucose (40% of total solids) present. This results in excessive sweetness which appears to be accentuated by the monosodium glutamate present. As a possible replacement for the D-glucose, at least in part, attention is being directed toward the use of dextran since this material is water soluble, tasteless, of defined molecular weight and capable of yielding D-glucose on digestion. It is also anticipated that sorbitol may be used to complement the action of dextran inasmuch as it, too, is water soluble, has a pleasant taste, is non-reducing and is consumed via the same pathway by which D-glucose is metabolized.

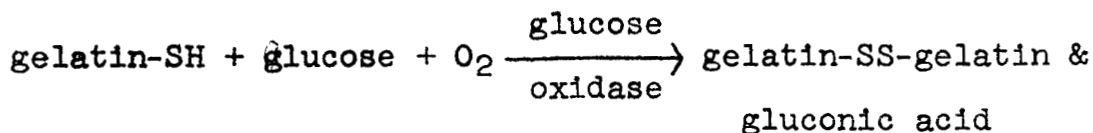
In order to overcome the flavor of L-methionine the initial efforts are being made to replace this amino acid with one of its metabolic intermediates, namely, homocysteine, inasmuch as the biological utilization of L-methionine involves the formation of this compound. To compensate for the absence of L-methionine methyl groups, it is planned to increase the level of choline and vitamin B₁₂.

The initial animal experiments therefore will be directed to assessing whether homocysteine and/or dextran can be substituted to advantage in diet formulations. The success of these two modifications is expected to simplify the job of improving diet flavor. This view is considered to be valid inasmuch as all of the other amino acids are either saline, sweet or only slightly bitter.

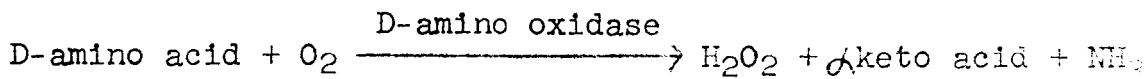
Replacement of all or part of the glucose by dextran or sorbitol is considered desirable, also, as a means of eliminating the browning reaction which has been shown to occur when the diets are heated: most probably the result of interaction between amino acids and the reducing groups of glucose. Though inhibitors of this reaction are known, it is considered preferable to avoid their use, if possible.

Another aspect of the problem being studied is the possibility of changing the consistency of the diet, as for example, producing gelled forms which would be more convenient to handle and would provide some variety of eating sensation more akin to solid food or candy. To this end we have demonstrated that thermally stable gels containing the diet in an immobilized state can be achieved by the use of thiolated gelatin in concentrations ranging upward from 1% by weight. Diets in the gel form offer the distinct advantage of reducing exposure to air oxidation and fragmentation in the state of weightlessness. In this form, they also readily lend themselves to being dehydrated into cubes to accommodate the present technology devised to feed astronauts in flight.

Most of the conventional oxidative crosslinking agents routinely used with thiolated gelatin appear to be unsuited for use in diet formulations owing to the risk of oxidative destruction of diet ingredients. However, it has been possible by the utilization of the D-glucose presently found in the diet formulations to achieve the non-destructive oxidation via the use of the enzyme D-glucose oxidase.



Finally, to sharpen analytical techniques for assaying amino acids, a simple rapid assay method for routinely determining the quantity of D-isomer present as contaminant in L-amino acids has been developed. In contrast to the Warburg technique which involves the use of expensive apparatus and is limited by the capacity of the instrument, the present technique employs a simple Conway cell and has the accuracy of the order of $\pm 0.02\%$. In the Warburg procedure (Meister, Leventow, Kingsley and Greenstein, J.Biol. Chem. 192, 535, 1951) measurement is made of the oxygen consumed. In the present technique, however, a colorimetric assay is made utilizing the ammonia liberated. The method has been calibrated against both ammonium salts and DL-valine. The reaction in question may be represented:



COST STATEMENT

A) Statement of Investigator Time and Cost:

<u>Investigator</u>	<u>Cumulative</u>	
	<u>Hours</u>	<u>Cost</u>
Norman Rosenthal, Project Director	292.25	\$1,996.98
Ralph Shapiro, Senior Chemist	38.75	250.00
Support Chemists:		
Joseph Burdige	119.50	455.87
Albert Seidner	241.00	641.02
Robert Braun	1.25	4.70
Joseph Garvey	20.25	50.30
Vincent Reardon	3.50	8.57
Totals	716.50	\$3,407.44

B) Statement of Total Costs:

	<u>Cumulative Costs Incurred</u>	<u>Estimated Completion Costs</u>
Direct Labor	\$3,407.44	\$49,092.50
Direct Materials	4,209.24	37,040.76
Other Direct Charges	575.30	3,774.70
Overhead @ 100% Direct Labor	3,407.44	49,092.50
Total Direct Costs	\$11,599.42	\$139,000.58
G & A @ 15% Total Direct	1,739.91	20,660.09
Total Costs & Expenses	\$13,339.33	\$159,660.67
Fee	771.01	9,228.92
Grand Total Costs, Expenses & Fee	\$14,110.34	\$168,889.66

C) Comments:

1. The above figures include time and costs in the amount of \$1,136.64 for Anticipatory Costs incurred from 7/14/62 thru 10/3/62 which have been billed to NASA on P.V. #1.
2. Of the total costs, expenses and fee charged thru 12/31/62 (\$14,110.34), 60.6% or \$8,549.72 was incurred during the month of December, indicating the accelerating activity being imputed to this effort.